obtained. In *saturated colors*, the smaller area is pleasanter except in the case of saturated red, where the larger area is pleasanter. All the *tints* showed slightly higher affective values for the larger areas. In the case of the *shades* there was a more marked preference for the larger areas except in the case of green.

We may conclude, then, that under the experimental conditions described (1) *saturated colors are preferred in smaller area, with the exception of saturated red, which is preferred in larger area;* (2) *the larger area of tints is slightly preferred;* and (3) *the larger area of shades is preferred, the preference being least in the cases of green and violet.*

There was no correspondence between the absolute affective value of a color and the preference for it in larger or smaller area. It may be noted that in this study as in the preceding ones, the highest absolute affective value was that of the blue tint and the next highest that of saturated red, also that yellow and orange had the lowest affective values among saturated colors, tints, and shades alike. Twelve of the twenty-three observers in this study were also observers in the study on An Effect of Fatigue on Judgments of the Affective Value of Colors.

XVII. Fluctuations in the Affective Value of Colors During Fixation for One Minute.

By Dorothy Crawford and M. F. Washburn

The materials used in this experiment consisted of pieces of the Bradley colored papers, 2.9 cm. square. This size was used in the present study, as in some of our other studies on the affective value of colors, for the reason that it can be conveniently cut from the sample books issued by the Bradley Company. Eighteen colors were used: saturated violet, blue, green, yellow, orange, and red, and the lightest tint and darkest shade of each. Each piece of paper was laid on a white ground before the observer, who was asked to express her judgment as to its pleasantness or unpleasantness by using one of the numbers from one to seven, in the ordinary way. The observer was further asked to look steadily at the color for an interval of one minute, measured by the experimenter, and to report by means of the appropriate numbers any changes in the affective value of the color. At the end of the period of fixation she was asked to give the reasons for the changes which had occurred. The same proceeding was repeated for each of the eighteen colors, in random order. Fourteen observers worked on the problem; all, as usual, women, and nearly all students. Eight of the observers had had practice in introspection. Several of them made the experiment more than once, at considerable intervals, so that the total number of experiments performed was twenty-seven.

For most of the observers some fluctuation did occur during the one minute period: the number of colors with which no fluctuation took place varied from fourteen, out of the eighteen, to none, and averaged between four and five. Our principal interest was in the causes which produced the changes in affective value. These changes may be roughly divided into two groups: *alterations due to changes in the color itself, and alterations due to purely mental causes.*

Under the first head, two obvious factors suggest themselves: adaptation and the presence of a negative after-image, due to shifting of fixation, in the neighborhood of the color. The effects of adaptation were variously described as 'fading,' 'dulling,' 'getting dirty,' 'getting darker.' The most important purely mental cause for change in the pleasantness or unpleasantness of a color lay in the occurrence of associated ideas. These were most frequently of definite things, such as violets or wall-paper; sometimes of

touch experiences, indicated by the words 'velvety,' 'soft,' Other mental causes of change concerned the affective process itself: they were expressed by 'getting used to it,' or 'getting tired of it.' Both of these last comments were surprisingly rare; getting used to the color was mentioned only six times as a cause of increased pleasantness, and getting tired of a color was twenty-two times given as a cause of increased unpleasantness. This is in comparison with one hundred and twenty-seven cases where change was due to the occurrence of an association.

When the number of cases of change due to each of these two principal classes of causes was counted up for each of the eighteen colors, it was found that *changes caused by alteration in the actual appearance of the color were decidedly more numerous in the case of the saturated colors* (133) *than in that of the shades* (93) *or tints* (70). The principal reason for this difference seemed to be the *greater frequency with which an after-image was noticed in the case of the saturated colors* (thirty-three times, as compared with three times for the tints and six times for the shades). The process of adaptation was about equally influential upon the three classes of colors. Besides adaptation and the negative after-image, our observers occasionally reported other changes in the appearance of the colors, such as alteration in the color-tone, orange getting pinker, green shade growing less yellow, and so on, which could not with certainty be ascribed to adaptation. Once in a while an observer would report that a color grew brighter as it was looked at: it is possible that this was due to renewed fixation after having shifted the eyes.

On the other hand, *changes due to purely mental causes were most frequent in the case of tints* (70); *shades came next* (59), *and saturated colors last* (55). This difference was in large measure due to the fact that *associations occasioned a greater number of changes in affective value in the case of tints* (47) *than in the case of shades* (39) *or saturated colors* (31). Saturated colors occur with less frequency in nature than unsaturated colors, and this fact would naturally make them poorer in associations: why tints should be superior to shades in associative power is not clear. The occurrence of an associated idea, when it produces a change in the pleasantness or unpleasantness of a color, is equivalent, of course, to a change in the source of the affection, just as truly as when the color itself changes under the influence of adaptation. But when an observer reports that she has grown 'used to,' or 'tired of' a color, these terms probably refer to a dulling of the affective process itself, apart from an alteration in its source. We have already noted that, in the comparatively short interval which we used, such changes were rare. This result was in part due, no doubt, to the fact that the conditions of the experiment set the mind of the observer towards finding some affective value, pleasant or unpleasant, in the colors, and growing used to and tired of a color are processes leading to the disappearance of affective value. The six cases of 'getting used' to a color were equally divided among shades, tints, and saturated colors. *The shades gave the most instances of lowered affective value through getting tired of the color* (11); *the saturated colors came next* (8), *and the tints last* (3). Very likely the tendency to get tired of shades is due to their being somewhat depressing. Getting used to and tired of colors may be called processes of affective adaptation. In addition to them, certain changes were reported which seemed to refer to the affective process itself rather than to its cause, but which were too indefinite to be classified; such, for instance, as 'growing depressing,' 'growing insipid.'

A further question which suggests itself is whether the above-mentioned causes of change in the affective value of colors were causes of increased or diminished pleasantness. This question is not a simple one. If we find, for instance, that a given cause such as adaptation produces in a given color more changes in the direction of increased affective value than in that of diminished affective value, we must bear in mind that a color

which started at the beginning of the one-minute interval with the maximum affective value, 7, would have no chance of increasing, while one which started at 1 would have no chance of decreasing. On the other hand, by far the greatest number of changes in affective value that occurred under the conditions of this experiment were changes of one place only in the scale. Therefore if the initial value of a color were anything but 7 or 1, the chances were about equal for a rise or a fall. It ought to be sufficient, then, to correct our comparison of the number of rises in affective value produced by a given cause for a given color with the number of falls, by taking account merely of the number of maximum and minimum judgments of initial affective value made for that color.

Adaptation and association were the only causes of change that occurred with sufficient frequency to make this calculation worth while. Its results were as follows:

Saturated violet had 7 for its initial value once, and 1 not at all. It had therefore a very slightly greater chance for decrease than for increase. There were six cases where associations produced an increase and two cases where they produced a decrease. Associations then, on the whole, exerted a favorable influence. There were seven cases where adaptation produced increase and three where it produced decrease: the influence of adaptation, then, is also favorable to this color.

Saturated blue had 7 once for its initial value and 1 three times. It had therefore more chance to increase than to diminish. Associations produced three increases and no decreases; hence they had no demonstrable influence. Adaptation on the other hand produced sixteen increases to one decrease, and undoubtedly had a favorable influence on the pleasantness of this color.

Saturated green as regards initial values was exactly like saturated blue. Associations had almost no influence upon it, occurring only twice as a cause of increase and not at all as a cause of decrease. Adaptation was favorable, with nine cases of increase to two of decrease, but its effect was not very marked.

Saturated yellow never had 7 for its initial value, while it had 1 three times; its chance for increase was therefore greater than that of blue and green. The effect of association was on the whole favorable; there were six increases and no decreases. The effect of adaptation was rather unfavorable: four increases to an equal number of decreases.

Saturated orange never had 7 for initial value, and had 1 five times. It had therefore decidedly more chance for increase than for diminution. Associations had little effect, the proportion of increase to decrease being five to two. Adaptation was also of small influence, the proportion being seven to four.

Saturated red never had 1 for an initial value, and had 7 seven times. Thus it had much more chance to diminish than to rise in affective value. On the whole the influence of association on this color must be considered favorable, for there were two increases and only three decreases, despite the greater likelihood of the latter. Adaptation on the other hand did saturated red no good; there were ten cases where it brought about a fall, and four where it brought about a rise.

Violet shade, having 7 and 1 for initial values once each, had balanced chances. The influence of association was then wholly favorable, the ratio of rises to falls being five to nothing. Adaptation was nearly as often unfavorable as favorable (six to eight).

Blue shade had decidedly more chance for fall than rise, 7 occurring ten times as initial value and 1 once. The influence of associations was negligible, as they produced change in two instances only. The effect of adaptation must be considered favorable, as there was an equal number, five each, of rises and falls assigned to it.

Green shade had equal chances for rise and fall, as neither of the extreme numbers was ever assigned to it at the outset. Associations were dis-

tinctly favorable to it, the ratio of rise to fall being six to one. Adaptation on the other hand had an unfavorable effect nearly as often as a favorable one (five to six).

Yellow shade had greatly more chance for increase than for decrease, 1 occurring twelve times as initial value and 7 not at all. The influence of associations was then but slightly favorable, the ratio of rise to fall being five to one. Adaptation seemed to have a somewhat unfavorable effect, causing four decreases to seven increases.

Orange shade had equal chances for increase and decrease, neither extreme occurring as its initial value. Associations were distinctly favorable to it, in the proportion of ten to three. Adaptation was a little more favorable than unfavorable (seven to five).

Red shade had more chance of decrease than of increase, as 7 was assigned to it four times at the outset and 1 never. The influence of association must then be reckoned as decidedly favorable, since it produced six rises and no falls. Adaptation on the other hand was perhaps a little more unfavorable than favorable in its influence, producing eight falls to four rises.

Violet tint had 7 for its initial value nine times and 1 not at all; it was therefore much more likely to fall than to rise. Association thus must have had a distinctly favorable influence to produce six increases and no decrease. Adaptation on the other hand had little if any effect, the proportion of falls to rises being two to ten.

Blue tint had somewhat more chance of decrease than increase, 7 occurring twice and 1 not at all as its initial value. The effect of associations was favorable, though not so markedly as with violet tint, the ratio of rise to fall being seven to two. Adaptation was unfavorable, causing nine decreases to four increases. *Green tint* had 7 six times and 1 once for initial value, and so was more likely to fall than to rise. Associations were favorable, producing five rises to one fall. Adaptation was distinctly unfavorable, causing thirteen falls to two rises.

Yellow tint had equal chances, 7 occurring twice and 1 twice. Association produced less effect upon this tint than upon any of the other tints, but such effect as existed was mostly favorable (five to one). Adaptation was equally unfavorable, producing one rise and five falls.

Orange tint had more chance of fall than of rise, 7 occurring five times and 1 once. The effect of association was on the whole favorable, producing eight rises and five falls. Adaptation had little effect, but that little was probably favorable, there being three increases to four decreases.

Red tint had nearly equal chances, leaning slightly towards fall, with two cases of 7 and one of 1. Associations were favorable to it, in the proportion of seven to one, but the effects of adaptation were balanced, eight to seven.

These results may be summarized in the following statements. *For saturated colors, associations have little influence, but what they have is predominantly favorable. Adaptation is favorable to violet, blue, and green, rather unfavorable to yellow and red, and without definite effect on the affective value of orange.* The colors of the warm end of the spectrum our observers seem to have liked quite as well in their original saturation as in the duller tones produced by adaptation. *In the case of shades, association produced a favorable effect upon violet, green, orange, and red; little effect of any kind upon blue, and nearly as much unfavorable as favorable effect upon yellow. The effects of adaptation were on the whole as often unfavorable as favorable to the shades. Associations are favorable to tints without exception, and adaptation was on the whole unfavorable.* Broadly speaking, *the tendency of associated ideas is to raise the pleasantness of a color, and the tendency of adaptation is to lower it rather than raise it.*

With two exceptions, in every case where an after-image was noticed, it diminished the pleasantness of the color.